

*CLARKIA CONCINNA* SUBSP. *AUTOMIXA* (ONAGRACEAE),  
A NEW SUBSPECIES FROM THE SOUTH BAY  
REGION, CENTRAL CALIFORNIA

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ABSTRACT

*Clarkia concinna* subsp. *automixa* Bowman is described from the South Bay Region of central California. Unlike typical *C. concinna*, this subspecies is not protandrous and is highly modified for selfing.

*Clarkia concinna* (Fischer & Meyer) Greene was described in 1835 from material collected near Fort Ross, Sonoma Co., California. Despite generic revision (Greene 1891), the species has remained intact, based on its distinctive petal configuration and possession of four anthers, a condition unique within sect. *Eucharidium*. The section contains two species, *C. concinna* and *C. breweri* (Gray) Greene (Lewis and Lewis 1955); both are endemic to northern and central California. Investigations of breeding systems within sect. *Eucharidium* have revealed two dissimilar forms within *C. concinna*. The southern form is strongly, if not exclusively, selfing. Further field investigations and examination of herbarium material support the taxonomic distinctness of this group, which I propose herein as a new subspecies.

*Clarkia concinna* (Fischer & Meyer) Greene subsp. *automixa* Bowman  
subsp. nov.

Subspecies *fabricata*, antheris distinctis. Flores nonproterandri, automixi, claudentes noctu; petala 12 mm longa. Chromosomata numero  $2n = 14$  (Figs. 1–5).

Annual, erect to diffusely branched, to 4 dm tall; stems glabrate or with minute, upwardly curled hairs. Leaves elliptic to ovate, entire, 2–3(–4.5) cm long, 6–20 mm broad, narrowed to petioles 5–25 mm long. Rachis of the inflorescence erect. Flowers erect in bud, becoming deflexed; sepals linear or narrowly oblanceolate, 1–2 cm long, 1–2 mm wide, commonly remaining united at the tips at anthesis, sharply deflexed at the middle, deep red and petaloid at the base; petals deep bright pink, the claw not streaked with white or purple, 8–12(–17) mm long, 4–8 mm broad, the blade 3-lobed, the lobes shallow, (2–)3–4 mm deep, petals closing the flower at night;



stamens 4, roughly equal, surrounding the style, filaments pinkish-lavender; anthers without hairs or only slightly ciliate, curling after dehiscence; pollen bluish with copious viscin threads; stigma white, obscurely 4-lobed, appearing capitate or bifid at maturity, receptive prior to or at anthesis, positioned with the anthers, clearly not protandrous. Chromosome number  $2n = 14$ . Flowering from mid-May to late June.

TYPE: USA, California, Santa Clara Co.: Mt. Hamilton Range, along Kincaid Rd., 11.1 km n. of Smith Creek Ranger Station, w.-facing slope 3 m e. of road in grassy oak woodland and ca. 300 m s. of locked gate across road, R3E T6S S29 nw.¼ nw.¼ (Mt. Day quad.), 37°23'13"N, 121°39'26"W, elev. 735 m, 29 May 1986, *Bowman 7001* (Holotype: UC; isotypes: CAS, CS, CSUC, GH, LA, MO, RSA, SJSU).

PARATYPES: USA, California, Alameda Co.: 2.4 mi w. of Sunol, 14 May 1938, *Constance 2233* (CAS, GH, RSA, UC). Santa Clara Co.: Montebello Rd., 3.1 mi w. of Stevens Canyon Rd., 16 Jun 1983, *Bowman 3202* (CS, CSUC, UC); 11.3 mi s. of Alum Rock Ave. on Mt. Hamilton Rd., 16 May 1985, *Bowman 6035* (CS, CSUC, UC); jct. Stevens Canyon Rd. and Redwood Gulch Rd., 24 May 1985, *Bowman 6076* (CS, CSUC, UC); Soda Spring Canyon, 28 May 1895, *Dudley 4029* (RSA); Congress Springs, 13 May 1904, *Heller 7412* (DS, GH, UC); Booker School near Saratoga, 19 May 1906, *Pendleton 346* (POM, UC); Poverty Flat, Henry Coe St. Park, 10 May 1972, *Powers 581* (SJSU); Smith Creek, 7 May 1934, *Sharsmith 1016* (DS, RSA, UC); headwaters of Stevens Creek, 3 Jun 1961, *Thomas 9517* (DS, RSA).

*Distribution.* *Clarkia concinna* subsp. *automixa* is limited to Santa Clara and southern Alameda cos., California (Fig. 6). Although it occurs extensively in the foothills surrounding the Santa Clara Valley, this subspecies is known only from Sunol Canyon in Alameda Co. It is common in mesic, shaded oak woodlands. In contrast, subsp. *concinna* ranges from extreme northwestern California southward to the Oakland Hills (Alameda Co.) and Mt. Diablo (Contra Costa Co.). The two subspecies are allopatric and are separated by a minimum distance of ca. 33 km.

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FIGS. 1–5. Floral variation in subspecies of *Clarkia concinna*. Specimens grown from field collections as indicated. 1. Top row, subsp. *concinna*, l. to r., *Bowman 6070*, *3336*, *6074*; bottom row, subsp. *automixa*, *Bowman 3685*, *3687*, *3302*; all at 1×. 2. Stigma exertion in subsp. *concinna*, *Bowman 6073*; 2×. 3. Stages in the protandrous development of subsp. *concinna* flowers. The interval between anthesis (top) and stigmatic receptivity (bottom) is 1–2 days; ca. 2×. 4, 5. Self-pollination in subsp. *automixa*, *Bowman 6036*; 2×. Stigmas in subsp. *automixa* are not protandrous and are positioned with the anthers at dehiscence.

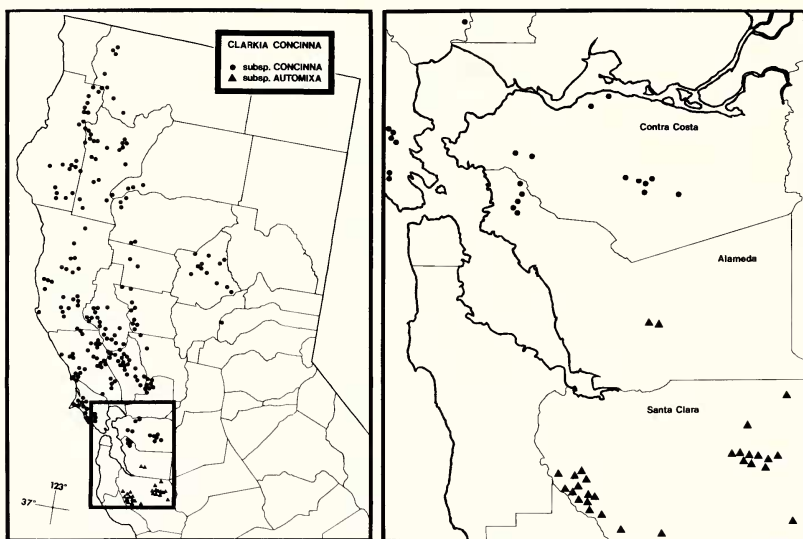


FIG. 6. Geographical distribution of *Clarkia concinna* subsp. *concinna* and subsp. *automixa* in northern and central California.

*Morphology and pollination.* *Clarkia concinna* subsp. *automixa* is distinguished by a combination of characters that promote selfing. Its flowers are smaller and markedly less variable (Fig. 1) than those of subsp. *concinna*, which are predominately outcrossed. Throughout its entire range, subsp. *concinna* is strongly protandrous (Figs. 2, 3); its anthers and stigmas are isolated temporally and spacially. The flowers of subsp. *automixa* are not at all protandrous (Figs. 4, 5) because the stigma becomes pollen-receptive before the bud opens and anther dehiscence occurs as the flower opens. The stigma is positioned in close proximity to the anthers, thus, facilitating self pollination. The corolla of subsp. *automixa* also lacks white streaks, particularly along the base of the claw, which are characteristic of subsp. *concinna*. MacSwain et al. (1973) noted that flowers in *C. concinna* remain open at night, an observation correct for all known populations of subsp. *concinna*. In contrast, all populations of subsp. *automixa* possess corollas that close tightly at night and appress anthers against the stigma, thus, promoting selfing. Undisturbed greenhouse plants of subsp. *concinna* generally fail to set seed, whereas those of subsp. *automixa* routinely set full complements of seeds. This confirms that the combination of morphological characters unique to subsp. *automixa* serves to facilitate selfing.

Figure 7 depicts the distribution of stamen/style ratios measured from all specimens of *Clarkia concinna* available at CAS, CS, CSUC, DS, GH, HSC, JEPS, POM, RSA, SACT, SJSU and UC. The dis-

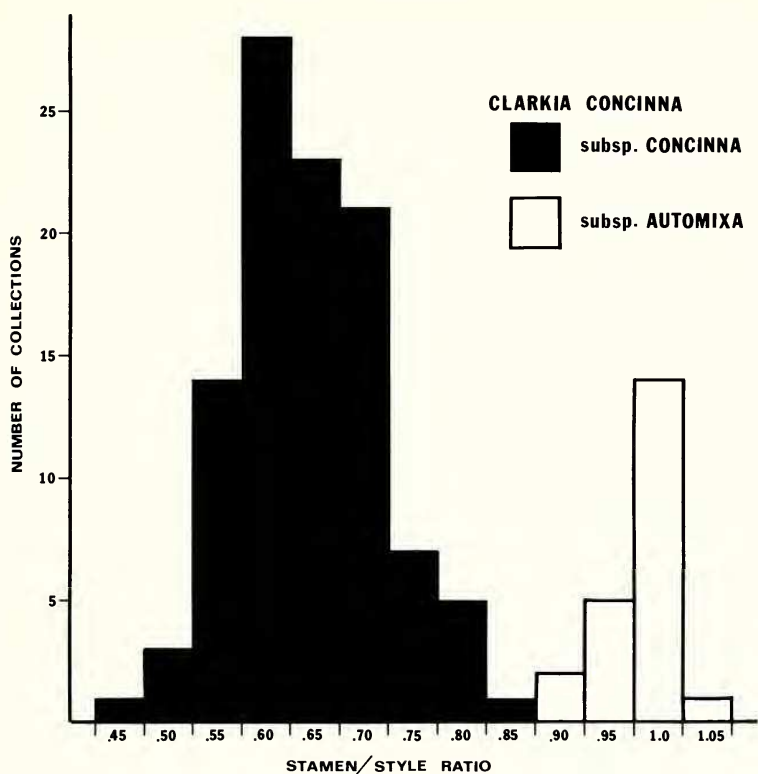


FIG. 7. Distribution of stamen/style ratios in *Clarkia concinna*. Stamens were measured from the base of the filament to the tip of the anther. Styles were measured from the distal tip of the ovary to the stigma surface. Only collections with three or more mature flowers were measured; values reported are averages of ratios from all available flowers on a specimen. Although the number of collections is clearly dependent on the total number of specimens examined, the two subspecies are defined by discontinuous stamen/style ratios.

continuous displacement of stamen/style ratios between the two subspecies agrees with evidence discussed previously. Curiously, those specimens of subsp. *concinna* (stamen/style ratio of 0.80–0.85) that most closely approach subsp. *automixa* are not from sympatric areas between the subspecies, but rather, from the extreme northern limits of the range of subsp. *concinna*. Thus, selfing may occur at both the extreme northern and southern limits of the species with allogamy predominating elsewhere. A similar pattern with selfing predominating at the margins of a species' range has been reported in *Lycopersicon pimpinellifolium* (Solanaceae) by Rick et al. (1977). Unlike the well developed autogamy in subsp. *automixa*, the northern populations of subsp. *concinna* show no signs of morphological



modification promoting selfing, other than stamen/style ratios approaching unity.

Taxonomic recognition of subsp. *automixa* is justified by comparison with other treatments in the genus. At least five *Clarkia* species have been described principally on their status as derived, primarily selfing, neospecies (Vasek and Harding 1976, Lewis 1973). Several subspecies in the genus, such as *C. tembloriensis* Vasek subsp. *calientensis* (Vasek) Holsinger (Holsinger 1985), *C. gracilis* (Piper) Nelson and Macbride subsp. *gracilis*, and *C. purpurea* (Curtis) Nelson and Macbride subsp. *quadrivulnera* (Douglas) Lewis and Lewis (in Lewis and Lewis 1955), also are based predominately on their selfing habit, even though the subspecies are not isolated from their conspecifics by geographic or other strong reproductive barriers. Subspecific taxa in *C. concinna* are differentiated by absolute geographical barriers and an assemblage of morphological characters. Although possible, gene flow between the two subspecies, as demonstrated by morphological continuity, is not in evidence. Gene flow is not likely, furthermore, because pollination of subsp. *concinna* is dependent on Lepidoptera and long-tongued Diptera (MacSwain et al. 1973). These insects are not known for long distance dispersal.

*Sectional affinity.* The geographical range of subsp. *automixa* is perhaps not based simply on ecological preference. Its range nearly matches the northern range of *C. breweri*, the only other species in sect. *Eucharidium*. Both species occur sympatrically at Congress Springs, Loma Prieta, Mt. Hamilton, and Cedar Mountain. Even though *C. concinna* and *C. breweri* overlap geographically, strong autogamy in subsp. *automixa* within this region prevents gene flow. Otherwise, all taxa within sect. *Eucharidium* (all  $2n = 14$ ) are easily hybridized by artificial means and the progeny are morphologically intermediate. The identical base numbers and the comparative ease with which artificial hybrids can be produced suggest that chromosomal repatterning may not have been important in evolution of the section, although it is prevalent elsewhere in the genus (Lewis 1962). Regardless of the mechanisms that enforce reproductive isolation in the section, lack of hybrids among herbarium specimens or in extensive field reconnaissance indicates that the integrity of each taxon is conserved. The factors governing evolution and reproductive isolation in the section remain to be elucidated.

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